NATURAL COOLING SYSTEM

An Eco-Friendly Alternative to Traditional Air Conditioning.

A DESIGN THINKING PROJECT REPORT

Submitted by

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TAMASOMA JYOTIRGAMAYA
Estd. 1995

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AICTE Approved; UGC Autonomous; JNTUH Affiliated; UGC "College with Potential for Excellence"; NAAC A++" Grade
ISO 9001:2015 Certified; QS I.GAUGE "Diamond" Rated; NIRF 2020: 127th Rank Engineering (151-200 Band Overall)
NBA Accredited: CE, CSE, ECE, EEE, EIE, IT, ME; JNTUH -Recognised Research Centres: CE, CSE, ECE, EEE, ME
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CERTIFICATE

This is to certify that the project titled **"NATURAL COOLING SYSTEM"** is being submitted, by **CH.ABHINAV (23071A0374, ME), A.PREETHAM (23071A1007, EIE), Y.SATHWIKA (24075A6721, CSDS), B.ASHISH SINGH (23071A7207, AIDS).** in partial fulfilment of the requirement for the award of degree of **Bachelor of Technology** to the Centre for Presencing and Design Thinking at the **Vallurupalli Nageswara Rao Vignana Jyothi Institute of Engineering and Technology** is a record of *bona fide* work carried out by them under our pedagogy. The results embodied in this Project have not been submitted to any other University or Institute for the award of any degree.

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ABSTRACT

The Natural Cooling System project aims to address the environmental and economic drawbacks of traditional air conditioning by developing a cost-effective, energy-efficient, and eco-friendly alternative. With rising awareness of climate change and the growing demand for sustainable solutions, the project focuses on designing a nature-inspired cooling system tailored for both residential and commercial spaces.

The Design Thinking process was employed to guide the development of the solution. In the Discover phase, empathy tools such as surveys, interviews, and stakeholder analysis were used to gather insights into user preferences, pain points, and needs. Users highlighted high electricity bills, uneven temperature distribution, and noise as major concerns with existing systems. In the Define phase, user personas and key insights were synthesized, revealing a clear need for a quiet, automated, and sustainable cooling solution. The Ideation phase involved brainstorming and stakeholder feedback to generate practical design alternatives, eventually leading to a prototype concept that integrates passive cooling techniques, water efficiency, and smart temperature control.

The Prototype was evaluated for desirability, feasibility, and viability, confirming its alignment with user needs and its potential to reduce energy consumption while maintaining comfort. The system also supports IoT integration, offering remote control and real-time temperature regulation. This project demonstrates how user-centered design can lead to impactful solutions that promote sustainability and improve quality of life. Future work will explore AI-driven enhancements and scalability for larger infrastructures.

LITERATURE SURVEY

1. Traditional Cooling Technologies and Their Impact

According to the International Energy Agency (IEA), air conditioners account for nearly 10% of global electricity consumption. Most conventional systems use hydrofluorocarbon (HFC) refrigerants, which are potent greenhouse gases contributing to global warming. These systems are also known for their high maintenance needs, noise levels, and uneven cooling patterns.

2. Natural Cooling Techniques

Literature on vernacular architecture reveals the effectiveness of traditional methods such as cross-ventilation, evaporative cooling, shading, and insulation in reducing indoor temperatures without relying on electricity. Studies by Givoni (1998) and Olgyay (1963) emphasize the role of climate-responsive design in passive cooling.

- Evaporative cooling techniques use water to absorb heat from the air, lowering indoor temperature efficiently in dry climates.
- Earth-air tunnels and green roofing have also shown potential in modern sustainable design.

3. Integration of Technology and Nature

Recent advancements have shown that integrating IoT sensors, AI-powered temperature control, and automated airflow systems with passive cooling can greatly improve performance while ensuring user comfort. Research by Zhang et al. (2020) discusses smart environmental control systems that adapt to user preferences and ambient conditions in real-time.

4. Gaps Identified

Despite many innovations, there is limited implementation of affordable, smart, and scalable natural cooling systems for middle-income households and small businesses. This project aims to bridge that gap by applying design thinking to build a prototype that is not only efficient and sustainable but also aligned with modern user needs.

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CHAPTER 1
INTRODUCTION

1.1 Objective

The main goal of this project is to develop a natural cooling system that reduces electricity usage while maintaining comfortable indoor temperatures. It aims to provide a cost-effective, energy-efficient, and environmentally responsible alternative to traditional air conditioning systems.

1.2 Introduction

Traditional air conditioners cool well, but they use a lot of electricity and release harmful gases into the environment. They also cool unevenly and can be expensive, especially in hot places where they're used a lot. This project looks for a better, natural way to keep spaces cool. By using Design Thinking, we studied what users really need and came up with a smart, eco-friendly, and affordable cooling solution.

1.3 Motivation

Rising electricity costs and increasing awareness about climate change have highlighted the inefficiencies and environmental harm caused by conventional cooling systems. India, being a tropical country, witnesses widespread use of air conditioners, leading to high carbon footprints. A sustainable solution that provides comfort without contributing to environmental degradation is the need of the hour. This project is motivated by the goal of delivering such a solution through a structured innovation approach.

1.4 Scope for the Project

- Focuses on cooling solutions for residential and small commercial spaces.
- Utilizes passive cooling methods and modern IoT-based automation for smart regulation.
- Excludes HVAC system overhaul or large industrial-scale implementation.
- Emphasizes user comfort, sustainability, and low maintenance.
- Encourages future integration with solar energy and AI-based control.

CHAPTER 2

DISCOVER AND DEFINE

2.1 Empathy Tools and User Understanding

To deeply understand the cooling-related problems faced by users, we adopted multiple empathy tools. These tools helped us gain insights into their daily experiences, challenges, and expectations from a cooling system. Empathy is the foundation of the Design Thinking process, and it allowed us to keep the user's needs at the center of our solution.

User interviews and surveys were conducted among homeowners, office workers, and facility managers. The tools used included:

- Google Forms
- In-person interviews
- Stakeholder mapping

Key findings:

- People dislike the noise and energy costs of air conditioners.
- Many users are open to sustainable options if they offer comfort and reliability.

Fig 2.1 Empathy Interviews

Stakeholder Group	Pain Points Identified	Expectations
Homeowners	High bills, dry air, loud AC noise	Low-cost, smart, eco-friendly solutions
Office Workers	Uneven cooling, distracting sound	Silent and uniform temperature control
Facility Managers	Maintenance-heavy systems, inefficient layout	Low-maintenance and reliable systems

Table 2.1: Summary of Stakeholder Interview Insights

2.1.1 Research Methods Used

We used a combination of qualitative and quantitative research methods to gather meaningful data. This included surveys to understand preferences, interviews with homeowners and office workers, and questionnaires to capture detailed feedback on traditional cooling systems. This allowed us to triangulate the information for accurate insight development.

Method Used	Description	Sample Size
Surveys (Google Forms)	Collected data on preferences, pain points, and features	50+
In-person Interviews	Explored deep behavioral insights	15
Questionnaires	Captured feedback on current systems and desired features	40

Table 2.2: Research Methods Overview

2.11.1 Stakeholder Analysis.

stakeholder analysis was conducted to identify key individuals who are directly or indirectly affected by the cooling system. This included:

- **End Users:** This group includes homeowners and office workers who experience the effects of traditional cooling systems daily. Their primary concerns revolve around comfort, cost, and usability.

- **Service Providers:** Facility managers and maintenance technicians fall under this category. Their insights helped us understand the challenges associated with installation, servicing, and long-term reliability.

- **Influencers:** This group comprises architects, interior designers, and sustainability consultants. Their expertise is valuable in ensuring that the cooling system integrates seamlessly with modern infrastructure and eco-design standards.

This helped us ensure our solution addressed the holistic ecosystem surrounding the cooling environment. Their feedback significantly influenced the design parameters, especially in terms of functionality and usability.

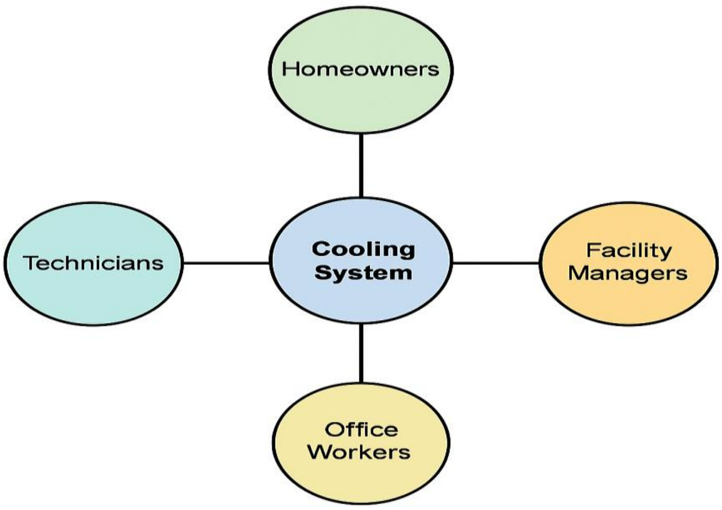


Figure 2.2: Stakeholder Mapping Diagram

2.2 User Persona and Needs

From our primary research, we developed user personas that reflect the typical users of our cooling solution. This persona summarized their daily struggles with existing cooling systems, such as high electricity bills, noise, uneven cooling, and lack of automation.

User needs

Primary needs

- Affordable and energy-efficient cooling
- Uniform temperature distribution (no hot/cold spots)
- Eco-friendly design using natural methods

Secondary needs

- Low maintenance requirements
- Long system lifespan
- Quiet operation suitable for work or rest
- Smart, automated temperature regulation

Latent needs

- Sustainable solution that reduces carbon footprint
- Integration with smart home systems (IoT-based cooling)
- Water-efficient system with minimal resource consumption

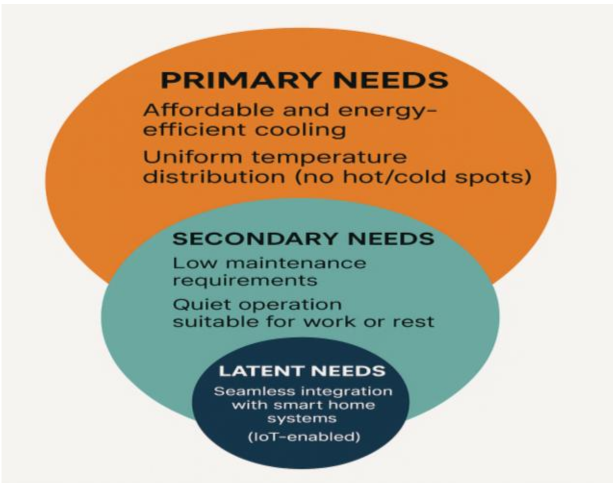


Figure 2.3: Visual Representation of User Need

CHAPTER 3
CUSTOMER SERVICE EXPERIENCE

3.1 Service Experience Overview

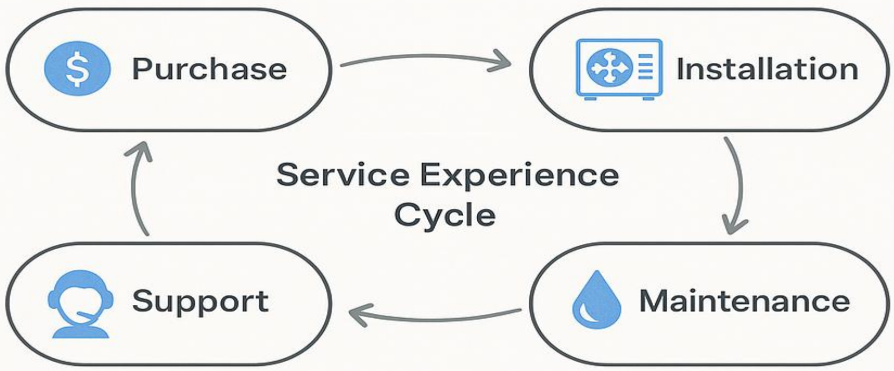
The service experience of a cooling system encompasses every touchpoint a user has with the system — from selection and purchase to daily operation and after-sales support. This holistic view considers not only the physical interaction but also emotional and cognitive responses like trust, satisfaction, and perceived value.

In traditional systems, users frequently express dissatisfaction due to:

- **High energy consumption**, resulting in steep electricity bills.
- **Uneven or delayed cooling**, especially in larger or multi-zone spaces.
- **Operational noise**, which disturbs peace in home or work environments.
- **Complicated user interfaces**, making it hard for non-tech-savvy individuals to manage settings.
- **Frequent servicing or part failures**, leading to additional costs and discomfort.

Our project aims to redefine the cooling experience by introducing an alternative that is not only energy-efficient and cost-effective, but also intuitively designed, silent, and environmentally sustainable. The goal is to shift the paradigm from product-centric thinking to user-centric innovation — ensuring every stage in the service cycle enhances comfort and trust.

The service experience focuses on how users interact with cooling systems in their homes and workplaces, and how their comfort, energy usage, and satisfaction are affected.



Stage	Key Activity	User Concern
Purchase	System Selection	Cost, Energy Rating
Installation	Setup and Placement	Complexity, Time, Space Constraints
Daily Usage	Regular Use	Noise, Comfort, Ease of Control
Maintenance	Servicing Needs	Frequency, Cost, Downtime

Table 3.1: Service Experience Cycle and Associated User Concerns

Key Insights

- The most critical pain points lie in the usage and maintenance phases.
- Users are increasingly looking for smart, low-maintenance, and quiet solutions.
- Proactive support, such as app alerts for servicing or AI-based fault detection, is a growing expectation.
- Redesigning the experience around convenience, automation, and peace of mind significantly improves satisfaction and loyalty.

3.1.1.1 Touchpoints Identified

Key touchpoints where the user interacts with the system include:

- **Initial Interaction:** During setup or installation where the user expects a quick, guided process.
- **Daily Use:** Through smart interfaces or voice-enabled controls, ensuring ease of use.
- **Maintenance Phase:** Users prefer systems that notify them of servicing needs and require low upkeep.
- **Feedback and Support:** Users expect a responsive team or chatbot support that can help resolve issues quickly.

3.2 Pain Points Addressed

- High electricity consumption with traditional systems.
- Noise during operation, disturbing sleep and work.
- Non-uniform cooling, leading to discomfort.
- Frequent servicing needs, increasing operational cost.

Pain Point	Addressed By
High electricity consumption	Energy-efficient natural cooling mechanism
Noisy operation	Silent airflow systems and passive techniques
Uneven cooling	Uniform air distribution via system design
Frequent maintenance	Durable, low-maintenance structure

Table 3.2: Mapping of Pain Points to Proposed Solution Features

CHAPTER 4
IDEATION

4.1 Idea Generation Process

After identifying user needs and key challenges in traditional cooling systems, the ideation phase was initiated to brainstorm and explore multiple possible solutions. Using creativity-driven techniques and collaboration, our team worked on generating innovative ideas that align with sustainability, user convenience, and energy efficiency.

Several ideation sessions were conducted using whiteboards, sticky notes, and digital mind maps. The aim was to generate a wide range of ideas before narrowing down to the most feasible and impactful solution. All ideas were evaluated based on desirability, feasibility, and viability.

4.1.1 Ideation Tools Used

To effectively explore multiple directions, we used the following tools:

- **Mind Mapping:** Helped connect various user pain points to possible solution paths and uncover hidden relationships.
- **SCAMPER Technique:** This method guided us to innovate by:
    - Substituting traditional materials with natural ones (e.g., clay)
    - Combining evaporative and cross-ventilation techniques
    - Adapting age-old cooling practices from vernacular architecture
    - Modifying designs to fit smart home integration
    - Putting natural elements like water and air to better use
    - Eliminating noisy components
    - Rearranging airflow patterns for better distribution
- **Brainwriting:** Each team member independently wrote down ideas without being influenced by others, followed by a collaborative review. It helps generate a wide variety of ideas without being influenced by others’ opinions or dominant voices in the group.

How It Works:

1. **Individual Idea Generation (Silent Phase):**
   - Each member writes 3–5 ideas related to a problem or theme.
   - No talking is allowed to ensure pure, uninfluenced creativity.
   - Time limit: 5–10 minutes.
2. **Idea Sharing or Rotation:**
   - The ideas are either shared anonymously or passed to the next member.
   - Each person reads others' ideas and adds to or builds upon them.
   - This can be repeated for 2–3 rounds to evolve and refine ideas.
3. **Group Discussion & Clustering:**
   - After all rounds, the team comes together to discuss and categorize the ideas.
   - Similar ideas are grouped and the most promising ones are selected for further development.

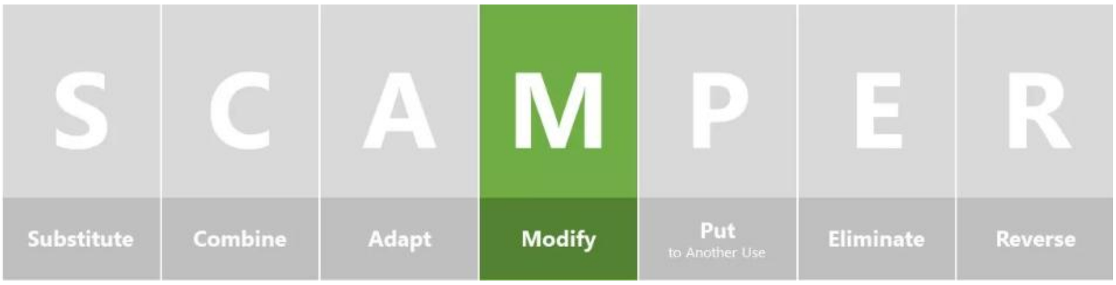


Figure 4.1: Modify method in Scamper

These tools enabled us to explore unconventional directions and refine ideas that align with modern sustainability goals. The methods also supported inclusive team contribution, minimizing bias in idea selection. This systematic exploration laid the foundation for a well-validated final concept.

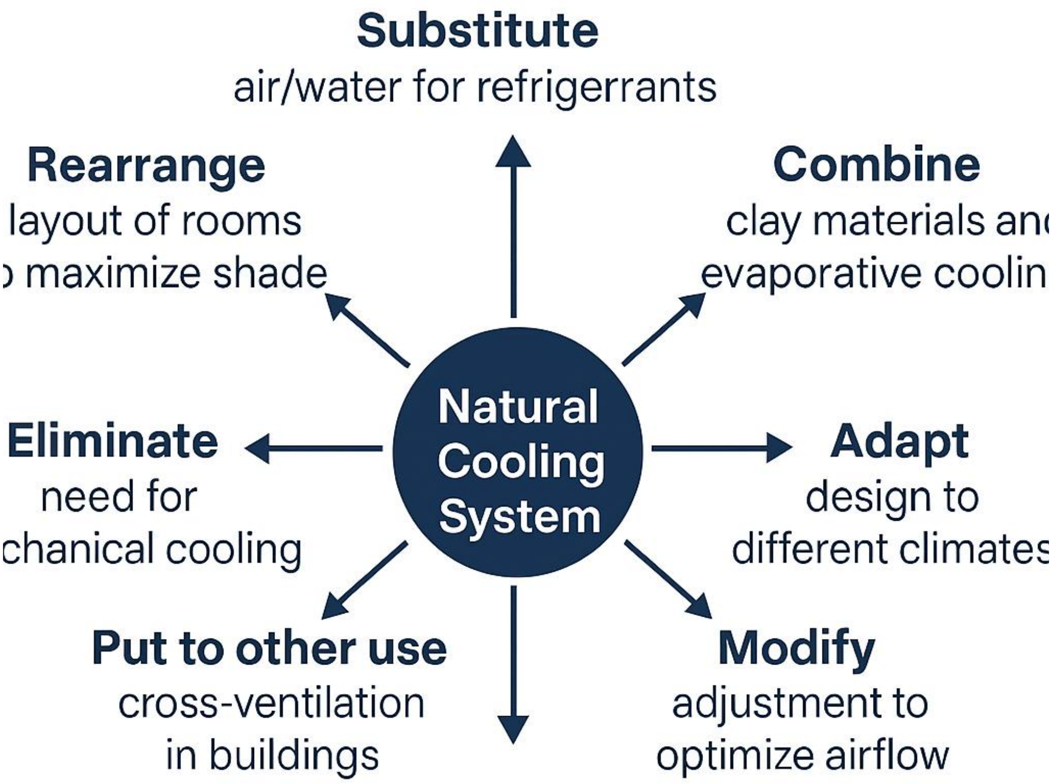


Figure 4.2: SCAMPER Technique Adapted for Natural Cooling

4.1.1.1 Sample HMW Question

To guide the ideation process, the following HMW questions were explored:

- How might we reduce electricity usage while maintaining cooling comfort?
- How might we create a quiet cooling system that doesn’t disturb sleep or work?
- How might we use natural elements like air, water, or clay to assist cooling?
- How might we design a system that adjusts itself based on room temperature?

4.2 Outcome of Ideation Phase

After several rounds of brainstorming, evaluation, and refinement using methods like Mind Mapping, SCAMPER, and Three-Box Thinking, the team arrived at the most viable and impactful concept for the project. This concept focuses on developing a Natural Cooling System that merges traditional passive cooling techniques with modern IoT-based automation.

Selected Cooling Techniques:

1. **Evaporative Cooling**
   Leveraging the principle of heat absorption through water evaporation, this technique cools the air naturally and efficiently, especially in dry climates.

2. **Clay-Based Cooling Panels**
   Made from eco-friendly materials, clay panels regulate indoor temperatures by absorbing and releasing heat slowly. Their porous nature also supports minor evaporative effects.

3. **Cross-Ventilation Architecture**
   Structural design alterations ensure proper air circulation throughout the space, reducing reliance on mechanical systems and promoting a fresher indoor environment.

4. **Water Flow-Assisted Thermal Cooling**
   Incorporating channels or pipes through which cool water flows, this technique helps lower surrounding temperatures through conduction and convection.

Integration with IoT Automation:

The system is enhanced with **sensor-based smart technology** that:

- Continuously monitors room temperature and humidity levels.

- Automatically triggers appropriate passive or active responses (e.g., opening vents, adjusting water flow).

- Provides real-time data and control through a simple user interface (mobile/web dashboard).

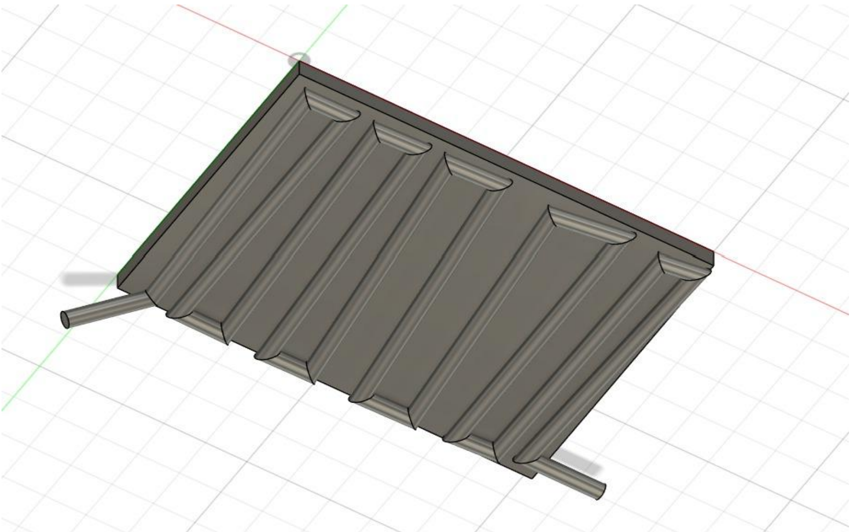


Figure 4.3:
Initial CAD design of prototype

BILL OF MATERIAL(BOM):

- Cardboard sheet of 5mm thickness
- Pump of 5Watt and 300L/Hr
- Copper coil of 3 meters
- Tank of 10 L
- Thermal sensor
- Ardino IDE
- Clay pot

CHAPTER 5
PROTOTYPE MODEL

5.1 Prototype Overview

We developed a basic prototype of the natural cooling system to demonstrate our idea and test its key functions. The prototype uses natural materials and passive design elements to provide cooling without depending heavily on electricity. It also includes a simple sensor-based automation feature for smart temperature control.

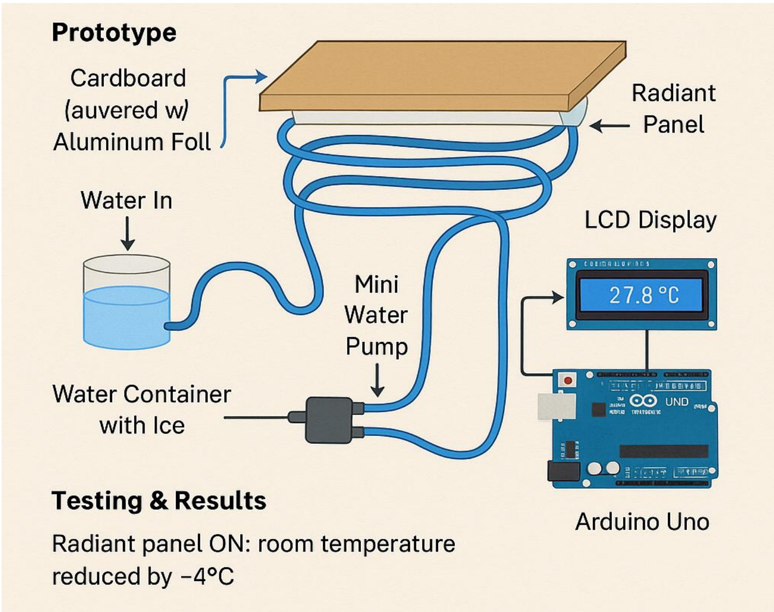


Figure 4.4: Block diagram of Natural Cooling System

5.1.1 Key Features of the Prototype

The prototype focuses on using low-energy, eco-friendly methods to cool indoor spaces. It includes:

- Clay pots and water-based evaporation setup to cool the air naturally.
- Cross-ventilation design to allow fresh air circulation.
- Basic temperature and humidity sensors connected to a microcontroller for automatic fan control.

5.1.1.1 Latent Needs Addressed

Our prototype addresses hidden user needs such as:

- Reducing carbon footprint by not relying on air conditioners.
- Using minimal water and power to ensure sustainability and efficiency.

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5.2 Evaluation Based on Desirability, Feasibility & Viability

• **Desirability**: The system meets the expectations of users who want eco-friendly and quiet cooling with smart automation.

• **Feasibility**: It can be easily built with locally available materials and simple electronic components, making it practical to develop and scale.

• **Viability**: Since it reduces power use and maintenance costs, it is affordable and sustainable in the long run, especially for middle-income households and small.

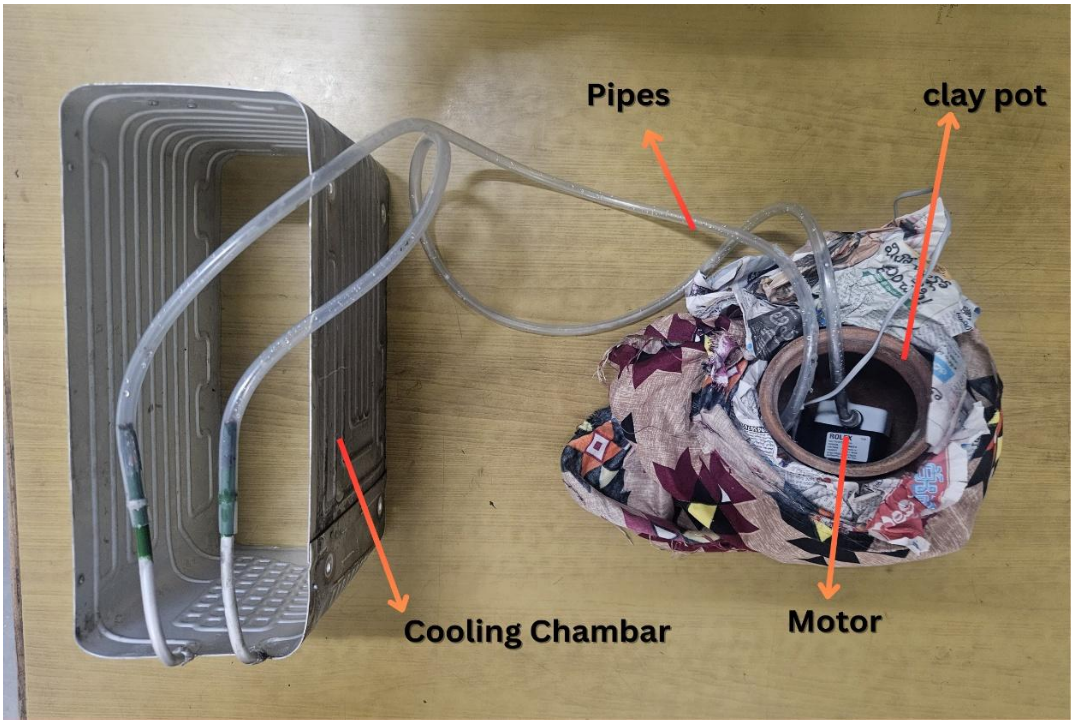

Figure 4.5: Final Prototype of Natural Cooling System

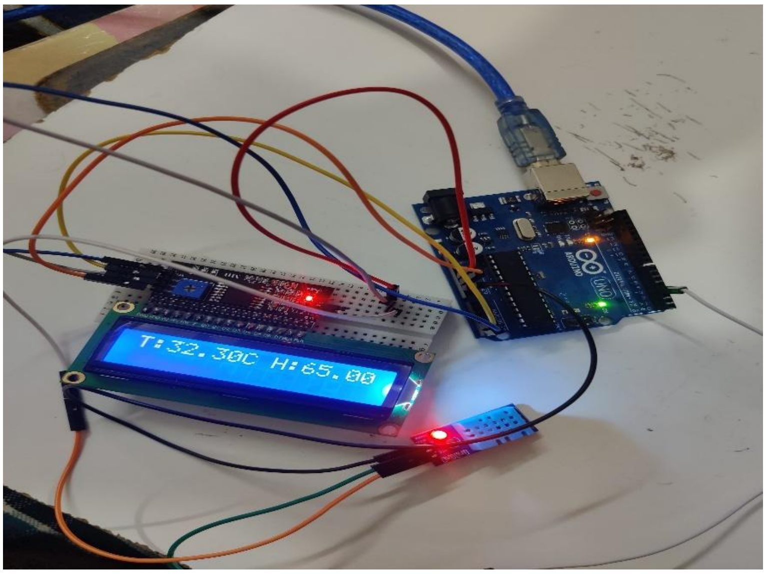

Figure 4.6
Temperature and Humidity Monitoring Using Arduino and DHT11 Sensor

Working Process of the Natural Cooling System

Image 1: Cooling System

- A clay pot with ice water is connected to a mini water pump.
- The pump sends cold water through a metal cooling panel using tubes.
- This helps cool the air as water passes through the panel.

Image 2: Sensor and Display Setup

- An Arduino Uno, DHT11 sensor, and LCD screen are used.
- The sensor checks the room temperature and humidity.
- The LCD shows this data in real-time.
- When the temperature goes too high, the system gets ready to cool.

How It Works Together

1. Sensor detects heat.
2. Arduino turns on the pump.
3. Cold water flows and cools the room.
4. The system saves electricity and is eco-friendly

CHAPTER 6
CONCLUSIONS AND FUTURE SCOPE

6.1 Conclusions

The project successfully explored an alternative, natural approach to cooling that is both sustainable and user-friendly. By applying the Design Thinking process, we gained deep insights into user problems and preferences. Our prototype showed that it is possible to achieve indoor cooling using eco-friendly materials and smart automation without relying heavily on electricity.

6.1.1 Key Outcomes

Identified pain points with traditional cooling systems such as high energy use, noise, and maintenance. Designed a low-cost, quiet, and efficient natural cooling solution. Integrated basic IoT features for smart control, meeting user expectations for modern automation.

6.1.1.1 Impact of the Project

This project can help reduce carbon emissions, lower electricity bills, and promote green living. It shows how simple natural methods, when combined with technology, can provide powerful solutions for everyday problems.

6.2 Future Scope

- In the future, this model can be developed into a full product by enhancing the smart features using advanced IoT platforms.
- More efficient materials and designs like phase-change materials or green roofing can be explored.
- It can be customized for larger buildings and different climate zones.
- Field testing in real-life environments like homes or offices will provide more data for improvements.
- It also opens up opportunities for collaboration with smart home companies or government programs promoting energy-saving technologies.

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Appendix A: User Surveys

A.1 Questionnaire for Users:

To ensure that the proposed Natural Cooling System aligns with actual user expectations and resolves real pain points, we developed a detailed questionnaire. The goal was to capture feedback on existing cooling systems and assess openness to eco-friendly innovations.

We prepared a simple questionnaire to collect user feedback regarding their experiences and expectations from cooling systems. It focused on energy costs, comfort, maintenance issues, noise concerns, and interest in eco-friendly alternatives.

Sample Questions Included:

- How satisfied are you with your current cooling system?
- What are the major issues you face (cost, noise, uneven cooling, etc.)?
- Would you prefer a natural or eco-friendly cooling system?
- How frequently do you service your cooling system?
- How important is smart automation in your cooling system?
- Would you invest in a low-maintenance, sustainable cooling solution?

A.2 Text Transcripts of User Responses

Collected responses provided a broad overview of the challenges users face and their expectations from a better solution. The user feedback supported the development of a system that is energy-saving, quiet, and technologically enhanced.

Summary of Insights:

- A majority of respondents (approx. 78%) reported dissatisfaction with electricity bills due to prolonged AC usage, especially during summers.
- Nearly 65% expressed discomfort due to noise or vibration from traditional air conditioners.
- Over 70% favored a system that incorporates smart temperature control, especially in work-from-home settings.
- Around 82% showed interest in trying a natural or eco-based cooling system, provided it is reliable and affordable.

- Most users (about 76%) highlighted frequent maintenance needs as a key frustration and showed strong interest in low-maintenance solutions.
- Several respondents recommended the use of sustainable materials and even expressed interest in solar-powered options.

User Feedback Quotes:

- "My AC runs all day in summer, but my room is still not evenly cool. I wish it worked better without the noise."
- "If there's a quiet, smart, and natural system available at a fair cost, I'd switch in a heartbeat."
- "Maintenance is a nightmare for my AC. If I can reduce that and save money, I'm all for it."